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# BULLETIN

OF THE

## AMERICAN PHYSICAL SOCIETY

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PROGRAMME OF THE

## NEW YORK MEETING

AT

COLUMBIA UNIVERSITY

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# The American Physical Society

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The President, Vice President, Secretary, Treasurer, Managing Editor, the three Past Presidents most recently retired from office, eight elected members and all Past Presidents first elected to the office of President prior to December 1932 constitute the Council which shall have general charge of the affairs of the Society.

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# BULLETIN

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AMERICAN PHYSICAL SOCIETY

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JANUARY 6, 1943 Vol. 18, No. 1

# BULLETIN

OF THE

# AMERICAN PHYSICAL SOCIETY

NEW YORK MEETING, JANUARY 22–23, 1943

THE **253rd meeting of the American Physical Society,** postponed from December 28–30 on account of the congestion of the railroads during the holiday season, will be held at Columbia University in New York City on Friday and Saturday, January 22 and 23, 1943. In spite of the chronological paradox, it will be designated as the Annual Meeting of 1942. The American Association of Physics Teachers (AAPT) and the American Society for X-Ray and Electron Diffraction (ASXRED), having likewise deferred their December meetings, will join us at the new dates. Our registration desk will be set up and sessions will be held in the Pupin Physics Laboratories of Columbia University, New York City; so also in all probability will be the sessions of the other societies. Our first session commences at 9:30 on Friday morning.

**Hotel.** The Hotel Pennsylvania (across the street from Pennsylvania Station) offers us single rooms at $3.85 and up, double rooms at $5.50 and up. Reservations should be made *immediately*, and members should mention that they belong to the Physical Society. To go from the hotel to the Pupin Laboratories, proceed to the IRT subway (under the front entrance of the hotel), and take an *uptown* train marked either "B'way-7th Ave. Express—Van Cortlandt Park" or "B'way-7th Ave. Local—137th St." Get off at 116th Street, and walk three blocks north to 119th Street, turning there to the right through the campus gates. Allow 35 minutes. If on emerging from the subway at 116th Street you find yourself on Lenox Avenue, you have failed to follow the foregoing instructions, and should take a train in the reverse direction back to 96th Street and try again (it would, however, be quicker to take a taxi).

**Contributed ten-minute papers** will be given in four sessions, beginning Friday morning at 9:30, Friday afternoon at two, Saturday morning after President Bridgman's address, and Saturday afternoon after Mr. Debye's address. All sessions will be in Room 301, Pupin Physics Laboratories.

The **Business Meeting** of the Society will be held on Saturday morning at 9:30.

The **retiring presidential address of President Bridgman** will be delivered immediately after the business session is concluded.

The **ASXRED** is the principal sponsor and agent of the Saturday afternoon session, which will begin at two o'clock with an invited paper by P. Debye, "Recent Developments in X-Ray and Electron Diffraction." It will continue with contributed ten-minute papers, some of which were evoked by the summons of the secretary of the ASXRED.

The **AAPT** will confer its **Oersted Medal** at 4:30 P.M. on Friday, and its **Richtmyer Lecture** by G. F. Hull, "The New Spirit in American Physics," will be given at 5 P.M. Both events occur in Brander Matthews Hall, 420 West 117th Street, east of Amsterdam Avenue.



JAN - 8 1943

The **dinner** of the American Physical Society, the AAPT and the ASXRED will be held on Friday evening at 6:15 at the Men's Faculty Club, 400 West 117th Street (east of the campus), at a price of $1.50. The fact that our meeting does not begin until Friday morning confronts us with a serious difficulty, for the manager of the Club needs to know on the previous day the approximate number of diners to be expected. It is therefore urgently requested that members notify this office by postcard if they hope to be able to attend the dinner. Informal attire is recommended.

The **annual Sigma Pi Sigma luncheon** for members and guests of this organization is scheduled for Friday at 12:15 P.M. in the Men's Faculty Club. Tickets at 85 cents must be obtained by advance reservation, to be made by writing to Professor M. W. White, State College, Pennsylvania; they will be held at the registration desk.

Mr. R. S. Ould of Washington is endeavoring to arrange a **symposium on radio techniques** applicable to physical measurements, similar to that which was held at Baltimore last May. If this is achieved the symposium will be held on Friday afternoon beginning at 2:00 in Room 428 of the Pupin Physics Laboratories.

The **Council of the American Physical Society** will meet at 8 P.M. on Thursday, January 21, in a place of which Council members will be notified. Members thereof who arrive in time will be welcome at dinner in the Faculty Club at 6:45.

**Subsequent meetings.** The meeting normally held in February will be omitted. Plans for the spring meeting in the latter part of April will be announced at a later date. During the intervening period there will be sectional meetings as follows: Metropolitan Section, New York City, March 26, 1943; New England Section, Wellesley (Mass.), April 3, 1943; Southeastern Section, Auburn (Ala.), April 2–3, 1943; New York State Section, Rochester, probably on April 3, 1943. Contributed papers will be accepted at the first three of these meetings. The secretaries of those three sections are, respectively: W. S. Gorton, Bell Telephone Laboratories, Murray Hill, New Jersey; Mildred Allen, Mount Holyoke College, South Hadley, Massachusetts; E. S. Barr, Tulane University, New Orleans, Louisiana.

### General Rules Relating to Papers

By vote of the Society on December 27, 1940, no paper may be accepted for presentation at any meeting of the Society unless the title and an abstract of the paper are delivered to the office of the American Physical Society not later than the closing date stated in the printed call for the meeting.

The time allowed for the oral presentation of a contributed paper is ten minutes at most.

When two or more papers are contributed by the same member, all but one are placed on the "supplementary programme." (A paper by two or more members is credited to the one first named in its title.) For each paper on this programme the Secretary indicates a session at which it may be presented. The presiding officer at this session may call for it when the other papers are completed, may require that it be given in shortened form, or may read it by title.

Titles and abstracts of the papers to be presented are given in the following pages. Proofs of these abstracts have not been submitted to the authors. After submission of proof the abstracts will be published in an early number of *The Physical Review*.

Karl K. Darrow, *Secretary*,
American Physical Society,
Columbia University, New York, New York

# PROGRAMME

## FRIDAY MORNING AT 9:30 O'CLOCK

**1. Decomposition of Matter Through the Magnet (Magnetolysis).** FELIX EHRENHAFT.—I have stated already that microscopic bodies, especially of ferromagnetic elements, do move in homogeneous magnetic fields, reversing their direction with the reversal of the field. In the spirit of M. Faraday and J. C. Maxwell one must therefore conclude that these test bodies carry an excess of north- or south-magnetic charge and consequently have to be called magnetic ions. Therefore we have to establish the equation; Div $B \gtrless 0$. A consequence of these facts is the phenomenon of magnetophoresis already published.* Lately I have discovered that the magnet causes chemical composition and decomposition of matter in several cases. The quantity of gas, originated in certain chemical processes occuring between the magnetrodes and the magnetolyte (e.g., acidulated water) is considerably increased by the application of the magnetic field. The gas created is a mixture of hydrogen and oxygen. Herewith is proved that the poles of a magnet break up water through magnetolysis, the same as electric poles break up water by electrolysis. Now the way is open to measure the intensity of the magnetic current.

It should be mentioned that the same electric potential of the magnetrodes is secured, be it by using one piece of metal for the magnet, or two pieces which are metallically connected.

* Science **94**, 232 (1941): **96**, 228 (1942).

**2. The Effect of Oblique Incidence on the Conditions for Single Scattering of Electrons by Thin Foils.** GERALD GOERTZEL AND R. T. COX, *New York University.*—In setting up and applying criteria for the single scattering of electrons by thin foils, it has been usual to assume that the principal deviations from single scattering are caused by the combination of small deflections with one large one. It is here shown that with electrons obliquely incident on the foil much more serious deviations may be caused by the combination of two deflections of the same order of magnitude. It is concluded that the difference observed by Chase and Cox[1] between the scattering at 90° to the two sides of a foil on which electrons are incident at 45° may be ascribed to this cause. The bearing of this factor on the negative result of Dymond's[2] experiment on the polarization of electrons is also considered.

[1] Chase and Cox, Phys. Rev. **58**, 243 (1940).
[2] Dymond, Proc. Roy. Soc. **A145**, 657 (1934).

**3. The Small Angle Scattering of Electrons by Aluminum.** BOWEN C. DEES AND BERNARD HAMERMESH, *New York University.*—The angular distribution of scattering of 46 kv electrons scattered by an aluminum foil of $1.3 \cdot 10^{-5}$ cm thickness has been studied in the angular range between 0° and 10°. The mean projected angle of scattering was determined experimentally for the cases of normal and 45° incidence, and the resulting experimental values were compared with the values predicted by a theoretical treatment given by Goudsmit and Saunderson.[1] Agreement with theory was found in each case. Attempted comparison with the theoretical treatment given by Williams[2] led to results which showed that his treatment was inapplicable to the circumstances of this experiment, and forced the conclusion that the scattering observed in this experiment was multiple for a very small angular range at most. Finally, investigation showed that the scattering found did not approach single scattering even at the largest angles of observation, and led to the conclusion that the observed scattering was mainly plural.

[1] Goudsmit and Saunderson, Phys. Rev. **57**, 24 (1940); **58**, 36 (1940).
[2] E. J. Williams, Proc. Roy. Soc. **169A**, 531 (1939); Phys. Rev. **58**, 292 (1940).

**4. Motion of the Copper Arc in Transverse Magnetic Field.** CHARLES G. SMITH,* *Raytheon Mfg. Co.*—An arc between equal parallel rings of copper is subjected to a transverse radial magnetic field. With lower ring as cathode and south pole at center, the arc viewed from above rotates counter-clockwise at atmospheric pressure, but below a critical pressure it rotates clockwise. The pressure for reversal varies approximately inversely as the distance between rings. Critical air pressures ranging from 36 to 3 cm were observed. The peculiar clockwise rotation results from the thermomotive force or Righi-Leduc factor operative in the solid cathode, according to one emission theory[1] of the mobile arc cathode. Mass movement of ionized gas caused by electromagnetic force tends to drive the arc around counter-clockwise. This tendency becomes less at reduced pressure since viscosity factors increase due to spreading of the arc column. Below the critical pressure, phenomena in the solid cathode predominate. The observations apparently extend the emission theory to include the copper arc over a wide range of pressure.

* Experiments performed at Harvard University.
[1] C. G. Smith, Phys. Rev. **62**, 48 (1942).

**5. The Adsorption of Thorium on Tantalum.** CHARLES J. GALLAGHER, *University of Notre Dame.*—It is known that thorium adsorbed on the surface of tungsten or molybdenum results in a decrease in the work function and also a decrease in the value of $A$, the emission constant.[1] The behavior of thorium on tantalum was investigated and similar effects were noted. Thorium was evaporated from thoriated tungsten onto a well-outgassed tantalum ribbon and the thermionic emission at 1390K studied as a function of the time of evaporation. The work function of the tantalum changed from 4.07 volts to 2.52 volts, while $A$ decreased by a factor of thirty. The ribbon was then held at 1550K and the emission from the two sides studied separately. The emission from the activated side decreased, while that of the clean side increased until both reached the same final level after about twenty hours. This indicates that the adsorbed thorium had migrated around the edges

of the ribbon and distributed itself uniformly over the emitting surface.

[1] A. L. Reimann, *Thermionic Emission* (John Wiley and Sons, New York, 1934) pp. 99, 134.

**6. The Action of Oxygen, Nitrogen and Hydrogen in Lowering the Photoelectric Work Function of Zirconium, Titanium and Thorium.** H. C. RENTSCHLER AND D. E. HENRY, *Westinghous Lamp Division.*—Pure wire surfaces of zirconium, titanium and thorium were made by thermal decomposition of the iodides. Photoelectric surfaces of the pure metals were prepared by the method previously described[1] and the work functions of these metals were determined from the photoelectric threshold wave-lengths. Zirconium and titanium when heated in pure oxygen, nitrogen or hydrogen dissolve considerable amounts of these gases. The photoelectric work functions of surfaces similarly prepared from the metals with the dissolved gases were found to be appreciably lower than for the corresponding pure metals and the photoelectric response from such surfaces is as constant as that from the pure metal. Thorium reacts with these same gases to a lesser extent and the shift in the photoelectric response is similar to that for zirconium and titanium.

[1] Rev. Sci. Inst. **3**, 794 (1932).

**7. The Photoconductance of Evaporated Bismuth Films.** A. H. WEBER AND L. M. FREDERICK, S. J., *St. Louis University.*—Observations were made of the dark conductance and photoconductance* of films deposited on Pyrex in high vacuum, continuously and discontinuously, both at room temperature and at liquid-air temperature. A photoconductance effect, observed in all the films deposited, disappeared in every instance at a critical thickness, 11 to 292 atom layers depending on the conditions of deposition. Films deposited continuously, both at room temperature and at liquid-air temperature, attained a greater respective thickness (2 to 3 times) before the photoconductance effect disappeared than did those deposited discontinuously. Films deposited at room temperature lost the photoconductance effect at a much greater film thickness (8 to 15 times) than did those deposited at liquid-air temperature. A film no longer exhibiting photoconductance at liquid-air temperature, when allowed to warm to room temperature, again showed a photoconductance effect. These observations lead to the conclusion that bismuth films exhibiting the photoconductance effects have a patch structure and that the increased electrical conductance when illuminated is not *true* photoconductance, but photoelectric emission from patch to patch.

* Defined as the electrical conductance of the films when illuminated.

**8. The Compensation of Random Fluctuations in a D.C. Bridge Amplifier.** J. C. M. BRENTANO AND E. R. SCHLEIGER, *Northwestern University.*—In measuring small potential differences or currents it is sometimes necessary to use d.c. amplification. Instances are the measurement of weak ionization currents or photoelectric phenomena involving delay actions where a.c. amplification cannot readily be adopted. A compensated symmetrical bridge using two thermionic tubes has the advantage over single tube circuits that it is easy to control; with it all disturbances and fluctuations can be eliminated very effectively, except fluctuations due to random changes of filament emission which actually set the limit to the ultimate amplification attainable. In a bridge* comprising two vacuum tubes, essentially of tetrode type, the intermediate grids acting as control grids, compensation for such fluctuations can be obtained by a system of cross connections between the inner grids and plates by which an emission fluctuation of one filament produces similar changes in the symmetrical halves of the bridge. The unsteadiness level can thus be reduced by a factor of thirty.

* Brit. Pat. 526869.

**9. Graphical Treatment of Non-Linear Circuits.** P. I. WOLD, *Union College.*—With the increase in the use of circuits containing non-linear elements, it becomes important to make calculations as to the behavior of any such circuit. Most non-linear elements have a volt-ampere characteristic which can be given by an infinite series only. The analytical treatment, therefore, becomes excessively burdensome unless all but a very limited number of terms of the series are neglected. This involves strong approximations. Graphical methods of treatment will be presented which avoid approximations and permit the ready plotting of the current characteristics of any branch in simple networks.

**10. The Ionization Cross Section of the Silver $L_{III}$ State.** J. J. G. MCCUE,* *Cornell University.*—The cross section of silver atoms for excitation to the $L_{III}$ state by cathode rays has been measured in arbitrary units as a function of cathode-ray energy, by using the thin target technique originated by Webster. The cathode-ray energies covered the range $1.5 \geqq U \geqq 9$, where $U$ = (cathode-ray energy)/(excitation energy). The cross section was determined from the $L\alpha$ doublet intensity, measured as a function of tube voltage and corrected for the effects of diffusion, rediffusion, retardation and fluorescence. The values of cross section computed by Burhop[1] by using the Born approximation and hydrogenic wave functions, vary in approximate agreement with the experimental results; the agreement however is not within the estimated experimental uncertainty of 3 percent. Comparison of the present results with those of Webster and his colleagues for the $K$ state establishes that for both the $K$ and the $L_{III}$ states of silver, the ionization cross section is a maximum when $U$ is about 3.5, and that for $U > 3.5$ the decrease in ionization cross section with increasing cathode-ray energy is more rapid for the $L_{III}$ state than for the $K$ state.

* Introduced by L. G. Parratt.
[1] Burhop, Proc. Camb. Phil. Soc. **36**, 43 (1940).

**11. Fine Structure in the X-Ray Absorption Edges of Potassium Chloride.** J. W. TRISCHKA, *Cornell University.*—Variations in the absorption coefficient in the regions of the $K$ edges of the potassium and chlorine in potassium chloride have been measured with a two-crystal vacuum

x-ray spectrometer. The region studied extended from ten volts less than the energy of the first absorption line to forty volts greater. Absorbers were prepared by evaporation of the potassium chloride onto a thin kodapak film. The lower limit of detectable variations in the absorption coefficients of the potassium and chlorine was three percent. Results were not corrected for the resolving power of the spectrometer. Using Sb $L\alpha_1$ and Pd $L\alpha_1$ as reference lines, the wave-lengths of the peaks of the first absorption lines were measured to be 3425.5 Siegbahn X.U. and 4378.8 Siegbahn X.U. for potassium and chlorine, respectively. The separation of the first two maxima in the chlorine edge was measured to be 3.9 volts as compared with the theoretical 4.2 volts calculated by Landshof[1] on the assumption that the maxima correspond to excitation states in the solid.

[1] R. Landshof, Phys. Rev. **55**, 631 (1939).

**12. An Error Arising from the Use of Small Carbon-Lined Ionization Chambers in the Measurement of Low Voltage X-Rays in Roentgens.** EDITH H. QUIMBY AND ELIZABETH F. FOCHT, *Memorial Hospital.*—With 44-kv x-rays, small ionization chambers of lucite lined with Aquadag give lower values for ionization per cc than open air chambers. In a parallel plate chamber of the lucite-Aquadag type, with electrodes perpendicular to the x-ray beam, ionization per cc increases steadily with electrode separation from 0.2 mm to 2.0 mm; after that, the *increment* of ionization per unit increase in volume is constant. The effect is attributable to the difference in the photoelectrons emitted by the carbon-coated electrodes, and by the air between the electrodes. When one electrode is made of aluminum the effect is reversed, the ionization per cc decreasing from 0.2 to 2.0 mm spacing. Theoretically, the ratio between the readings in carbon and aluminum chambers of this type, with very small spacing, can be calculated on the basis of Kramer's formula, the accepted formulae for ${}_c\tau$ and ${}_c\sigma_a$, and published absorption data. The ratio thus obtained is in satisfactory agreement with the experimental results. It is concluded that, for the measurement of x-rays in the voltage range in which photoelectric absorption is important, small carbon-lined ionization chambers do not satisfy the requirements imposed by the definition of the roentgen.

## FRIDAY AFTERNOON AT 2:00 O'CLOCK

**13. Electromagnetic Method for the Determination of Velocity Distribution in Fluid Flow.** ALEXANDER KOLIN, *Columbia University.*—A method has been developed which utilizes the principle of electromagnetic induction for determining the velocity distribution in a liquid. An homogeneous magnetic field is maintained at right angles to the direction of fluid flow. A potential gradient is established in the liquid by induction. Its magnitude at any given point is: $d\mathbf{E}/dz = \mu\mathbf{H} \times \mathbf{v}$. The local instantaneous velocity component in a direction perpendicular to the magnetic field and to the $Z$ axis is determined by measuring $dE$ at a given point. This is accomplished by introducing a probe consisting of two fine wires, insulated except at the tip ($dz$, the separation of the wire tips, is in the order of a few thousandths of an inch). The induced e.m.f. picked up by the probe is amplified and photographically recorded. The probe can be placed at any point where the instantaneous local velocity is to be measured. Since the method has no lag, it furnishes the velocity distribution in time as well as in space. To avoid difficulties due to polarization, an alternating magnetic field is utilized. This work was sponsored by the Department of Civil Engineering, and the author wishes to thank Professor B. A. Bakhmeteff for guidance and suggestions, and Professor J. K. Finch for his interest and generous support.

**14. Molecular Absorption of Vibration.** C. W. CHAMBERLAIN, *Michigan State College.*—The solution of vibration problems by means of springs is complicated by limitations introduced by resonance, load carrying capacity, stability and dampening factor. Springs constructed of organic materials like rubber in shear, sponge rubber, cork and highly compressed felt obey, to a greater or less degree, the same law as springs made of metal. A gas-filled cylinder with movable piston obeys the gas law and possesses high load carrying capacity. Its dampening factor, due to the fact that cooling of the gas on expansion is less than the heating on compression, is small. It has been found feasible to construct a series of gas-filled cylinders so short that the low heat conductivity of the confined gas introduces no limitation. Work done on the confined gas by the moving piston is directly transmitted to the cylinder base and rapidly disposed of by conduction. In operation although the initial temperature of the gas is high the temperature of the assembly of cylinders is comparatively low. Highly efficient absorption cushions composed of 100 cylinders in series and only $\frac{1}{4}$ inch thick have been successfully installed under machines varying in weight from a few pounds to 500 tons.

**15. On the Excitation Functions of Proton-Induced Reactions in Lithium.** E. D. COURANT, *University of Rochester.*—Evidence for the hypothesis that the ground state of ${}_3Li^7$ is odd has been obtained by comparing the experimental excitation functions of the reactions ${}_3Li^7(p, \gamma){}_4Be^8$ [1] and ${}_3Li^7(p, 2\alpha)$[2] to the computed penetration probabilities for protons of angular momentum 0 and 1. If ${}_3Li^7$ is odd, the $\gamma$-reaction is produced by protons of even angular momentum and the $\alpha$-reaction by protons of odd angular momentum, and vice versa. When the effect of the Coulomb potential barrier is eliminated by dividing the observed excitation functions by the penetration factor, the result corresponds to theoretical expectations only when the $\alpha$-excitation function is associated with the pene-

trability for $l=1$, and the $\gamma$ function with $l=0$, and not the other way around, leading to the conclusion that the ground state of $_3Li^7$ is odd. The penetrability has been taken to be proportional to $1/G^2\rho$ in the notation of Yost, Wheeler, and Breit.[3]

[1] Gentner, Zeits. f. Physik **107**, 354 (1937); Curran and Strothers, Proc. Roy. Soc. **A172**, 72 (1939).
[2] Haworth and King, Phys. Rev. **54**, 38 (1938); Rumbaugh, Roberts, and Hafstad, Phys. Rev. **54**, 657 (1938).
[3] Yost, Wheeler, and Breit, Terr. Mag. Atmos. Elec. **40**, 443 (1935).

**16. The Isotopes of Cerium and Rhodium.** ARNOLD A. COHEN,* *University of Minnesota.*—An analysis of the isotopes of cerium and rhodium has been made with a mass spectrometer in which ion currents are detected by an electron multiplier of the type described by Allen.[1] Dempster's[2] discovery of $Ce^{136}$ and $Ce^{135}$ was confirmed, and the abundance of these relative to $Ce^{140}$ measured as 1/500 and 1/400, respectively. No isotopes other than the four known ones were found, but the following upper limits of abundance relative to $Ce^{140}$ were set: $Ce^{134}$, $Ce^{135}$, 1/20,000; $Ce^{137}$, 1/10,000; $Ce^{139}$, 1/1000; $Ce^{141}$, 1/1500; $Ce^{143}$, $Ce^{144}$, $Ce^{145}$, $Ce^{146}$, 1/25,000. Rhodium was studied in an attempt to verify the existence of $Rh^{101}$, reported by Sampson and Bleakney[3] as being present to 1/1300 of $Rh^{103}$. Although 1/30,000 of $Rh^{103}$ could have been detected, no $Rh^{101}$ peak was found. Other upper limits relative to $Rh^{103}$ were determined as follows: $Rh^{105}$, 1/60,000; $Rh^{104}$, 1/6000; $Rh^{102}$, 1/5000. Columbium was also investigated, but a zirconium impurity prevented a search for $Cb^{91}$. An upper limit for $Cb^{95}$ was set at 1/4000 of $Cb^{93}$.

* Present address: RCA Manufacturing Co., Harrison, New Jersey.
[1] J. S. Allen, Phys. Rev. **55**, 966 (1939).
[2] A. J. Dempster, Phys. Rev. **49**, 947 (1936).
[3] M. B. Sampson and W. Bleakney, Phys. Rev. **50**, 732 (1936).

**17. Disintegration Scheme of $Co^{58}$.** L. G. ELLIOTT AND M. DEUTSCH, *Massachusetts Institute of Technology.*—Radioactive cobalt was separated from a nickel target which had been exposed to fast neutrons from the M.I.T. cyclotron. Examination of this source in the gamma-ray spectrometer[1] shows that it emits a gamma-ray of 0.810 ±0.015 Mev. No other gamma-rays were observed. The beta-ray spectrometer shows that it emits positrons with a maximum energy of 0.450±0.015 Mev. A counter sensitive to iron x-rays shows that a number of the disintegrations are by $K$ capture. The number of observed coincidences between beta- and gamma-rays and a knowledge of the efficiency curve for the gamma-ray counter used show that each positron is on the average accompanied by one 0.810 Mev gamma-ray. Observation of coincidences between the x-rays and gamma-rays show that at least 80 percent of the disintegrations by $K$ capture are also to the excited state 0.810 Mev above the ground state in the $Fe^{58}$ nucleus.

[1] M. Deutsch and A. Roberts, Phys. Rev. **60**, 362 (1941).

**18. The Mg II λ4481 Line in the Spectrum of Algol.** F. T. ROGERS, JR., *The University of Houston.*—A rather simple equation has been found for the profile of the λ4481 line in the uneclipsed spectrum of Algol. It is a representation of data taken by Struve and Elvey[1] from seven spectrograms (10A per mm dispersion at λ4500), and was developed for a further analysis[2] for rotation by the method of Carroll.[3] If λ represents wave-length in cm, $\lambda_0$ being the proper wave-length of the line, then the measured absorption in percent is

$$i(x) = 25.8e^{-1.21x^2}, \tag{1}$$

where

$$x = |\lambda - \lambda_0| \times 10^8. \tag{2}$$

This representation differs from the actual data by an average deviation of 0.3 unit of absorption, which is only about one-third the A. D.'s of previous representations.

[1] O. Struve and C. T. Elvey, M. N. R. A. S. **91**, 663 (1931).
[2] J. A. Carroll and Miss L. J. Ingram, M. N. R. A. S., **93**, 508 (1933); also reference 1.
[3] J. A. Carroll, M. N. R. A. S., **93**, 478 (1933).

**19. Thermal Diffusion Experiments with Ammonia and Argon.** W. W. WATSON AND D. WOERNLEY, *Yale University.*—Calculations from viscosity data indicated that even at 450°K the thermal diffusion constant $\alpha$ of $NH_3$ might be negative. In view of the nature of the intermolecular forces for $NH_3$, its critical temperature, and the known trend in $R_T$ values with varying temperature ($R_T$ = ratio of $\alpha$ to the value for hard spheres), it was thought that with decreasing temperature $R_T$ for $NH_3$ might change from + to − at some available $T$. With a "two-bulb" experiment, and $NH_3$ of about 15 percent $N^{15}$ content to increase the accuracy of the mass spectrometer analyses, which were made after converting to $N_2$, we have detected this effect. The shift from + to − values for $\alpha$ occurs, however, at about room temperature. At mean temperatures of 377°K, 285°K, and 247°K, $\alpha$ is +0.011, −0.004, and −0.009, respectively, indicating a rapid decrease in the repulsive force index and marked "softening" of the $NH_3$ molecule with decreasing $T$. With tank argon at 100 cm³/hr, two 3-meter hot-wire columns in series have been set into operation, the procedure being based upon the results of R. Simon. With the wires at 1100°K the separation factor is observed to increase at the average rate of 2.56 per day. After four weeks no decrease in this steady rate of rise has been noted.

**20. Determination of Chlorine Vibrations in Dichlorobenzenes from Intensities and Polarizations of their Raman Lines.** GERTRUD NORDHEIM AND H. SPONER, *Duke University.*—To facilitate the assignment of observed Raman lines of the dichlorobenzenes to motions in which mainly chlorine atoms are partaking, the intensities and polarization properties of these vibrations are studied theoretically. It is assumed that the change of polarizability in these vibrations is connected primarily with displacements of the chlorine atoms and that contributions from the individual atoms are additive. The Raman tensors belonging to the chlorine vibrations are then obtained by either adding or subtracting the single C−Cl contributions with reference to a chosen system of axes rigidly connected with the molecule. The following results were obtained: (1) *Valence vibrations.* The intensity ratio between the symmetrical and unsymmetrical vibrations is 8 : 1 (meta and ortho, the unsymmetrical vibration is forbidden in the para-spectrum).

Lines representing symmetrical vibrations are highly polarized, lines representing unsymmetrical vibrations have the depolarization factor 6/7. (2) *Deformation vibrations.* Our simplified theory gives complete depolarization for all allowed deformation vibrations, i.e., for symmetrical and unsymmetrical ones and also in and out of the plane. Lines from planar symmetrical vibrations are three times stronger than from unsymmetrical ones. Similar relations hold for nonplanar vibrations. These results are discussed in connection with existing experimental data.

**21. Transition Probabilities of the Asymmetric Rotor.** PAUL C. CROSS, *Brown University* AND G. W. KING, *Arthur D. Little, Inc.*—The successive convergents of the continued fraction used in calculating the energy levels of the asymmetric-rotor are closely related to the elements of the transformation matrix expressing the asymmetric-rotor wave-functions as linear combinations of symmetric-rotor functions.[1] This transformation was evaluated and applied to the direction-cosine matrices for the symmetric rotor in order to determine the Einstein transition probabilities for rotors having various degrees of asymmetry. The values determined enable interpolation to be carried out with sufficient accuracy for any molecule. The change in intensity of a given transition with increasing asymmetry is most marked for levels of high or low $\tau$-values, i.e., where the difference in the two limiting $K$ values is highest. Strictly speaking, the intensities given apply only to the pure rotational spectrum of a rigid molecule. In electronic and vibrational transitions the moments of inertia are markedly changed, but the tables can be used to give a satisfactory picture of the rotational structure to be expected in any given case.

[1] G. W. King, R. M. Hainer and P. C. Cross, J. Chem. Phys., in press.

**22. Raman Spectra of Symmetrical Top Acetylenes.** FORREST F. CLEVELAND AND M. J. MURRAY, *Illinois Institute of Technology.*—Raman data have been obtained for (A) *l*-iodo-*l*-propyne ($CH_3C{\equiv}CI$), (B) *l*-bromo-*l*-propyne ($CH_3C{\equiv}CBr$), (C) *l*-chloro-*l*-propyne ($CH_3C{\equiv}CCl$), and (D) 3,3-dimethyl-*l*-butyne ($C(CH_3)_3C{\equiv}CH$) in the liquid state. Relative intensities and depolarization factors were obtained by use of a Gaertner microdensitometer. $C_2H_5Br$ was present as an impurity in the sample used in obtaining the spectrum of (C) and depolarization factors were not obtained for this compound. Calculation shows that the $CX_3C{\equiv}CY$ molecule should have five $A_1$ frequencies and five E frequencies, all of which are active in the Raman effect. The $A_1$ frequencies should be polarized, the $E$ frequencies depolarized. The observations confirm these expectations, although there are some cases of doubling of lines due to resonance interaction. Since there is only a small increase in frequency for the gaseous state for such molecules, it is possible to make approximate thermodynamical calculations for molecules (A) and (B). In the triple bond region a line of medium intensity and smaller displacement than the strong triple bond line was observed for compounds (A), (B), and (C). This may be due to resonance interaction with the difference tone of the 2900 and 700 $cm^{-1}$ fundamentals. For compound (D), two lines, rather than the usual one for monosubstituted acetylenes were observed at 2106 and 2137 $cm^{-1}$.

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FRIDAY AFTERNOON AT 4:30 O'CLOCK

**Program of the AAPT**

Brander Matthews Hall

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SATURDAY MORNING AT 9:30 O'CLOCK

**Business Session of the American Physical Society**

followed by

**Retiring Presidential Address of President**

**P. W. Bridgman**

and by

**Contributed Papers**

**23. A Dynamical Approach to the Condensation Problem.** M. DRESDEN AND WILFRED KAPLAN. *University of Michigan.*—A number of attempts have been made to explain the condensation of a gas on the basis of statistical mechanics, starting from the classical or quantum-mechanical partition function. From this one proved essentially the existence of a singularity in the $p$, $V$ curve for sufficiently low temperatures. However this proof does not elucidate the physical mechanism of condensation. It might be possible to understand the condensation phenomena by

linking it with the stability conditions for dynamical systems. Consider the gas as a classical $N$-body problem, then by generalizing the concept of dynamic stability we can show that the stability of the system is essentially determined by the local structure of the energy manifold in the $3N$ dimensional phase space. So in order to determine where transitions can occur we must find out where the topology of the energy manifold changes, as we vary the total energy. For simple cases it has been shown that such changes occur;[1] dynamically, they correspond to the transition from bounded to unbounded orbits. The extension to the general case and the possibility of computing transition temperatures will be discussed.

[1] Wilfred Kaplan, Am. Math. Monthly, No. 5, May (1942).

**24. The "Génies" of Poincaré, and Carnot's Principle.** PIERRE DEMERS, *Montreal.*—Poincaré has proposed that perhaps a being that he calls a "génie," would see the individual molecules in a fluid mass; he could manipulate a trap to allow the faster molecules to accumulate in one compartment, where temperature would rise, against Carnot's principle. Maxwell has proposed the same, with "demons." This scheme was supposed to involve no energy expense. The theoretical possibility of this experiment is examined with the following conclusions: (1) Manipulating the trap involves *a minimum energy* $\sim kT/2$, from kinetic considerations. (2) To locate the molecules we can detect *photons*, diffused or emitted in a thin layer of molecules. A microscopist, or an automatic device, could manipulate the trap. It is seen that anyway some energy must be spent from the outside. (3) We can enclose the molecules to avoid loss of radiation, keeping them in *thermal and radiative equilibrium;* then we have a blackbody, in which details and individual molecules are indistinguishable; the "génie" would be unable to locate the origin of any one quantum perceived. Not seeing the molecules, he would be unable to sort them.

**25. On Strong-Coupling and Weak-Coupling Theories of the Meson Field.** W. PAULI, *The Institute for Advanced Study*—With the assumption that the meson has spin 0 and is described by a pseudo-scalar field, the model of an extended heavy particle (nucleon) leads to the strong coupling condition $f^2 \gg a^2$, where $f$ is the coupling constant with the dimension of a length, and $a$ is the size of the source. In connection with the prediction of excited states (isobars) of the nucleon, this theory leads to serious difficulties, since Dancoff and Serber[1] showed that the theory is in contradiction to the well-known saturation properties of the nuclear force, and Pauli and Dancoff[2] showed that it gives for the magnetic moments of the proton and the neutron values equal in magnitude but opposite in sign. On the other hand purely classical theories of the meson field which are based on the picture of a point source and which fulfil the condition of relativistic invariance were developed by Bhabha[3] and Fierz.[4] The singularities of the field due to the point character of the source are avoided by a suitable subtraction formalism. The author has shown that the classical point-source theories can be translated to quantum theory by the use of the so-called $\lambda$ limiting process of Wentzel and Dirac. The application of this method to the theory of meson field produces automatically the value 0 for the spin inertia, $K$, and gives convergent results for all quantum theoretical problems where the nucleons can be considered to be at rest. Such a weak coupling theory with point sources avoids all difficulties of the strong coupling theory with an extended source. For the scattering cross section of mesons by nucleons (due to the non-electromagnetic interaction), the results of this theory agree completely with that given by Heitler and Peng,[5] which is in fairly good agreement with experiment. No stable isobars of the nucleon exist in such a theory as long as $(f\kappa)^2 \ll 1$, a condition which is certainly fulfilled. In the problem of the interaction between two (or several) nucleons at rest, the perturbation theory holds for distances, $r$, of the nucleons for which $r^2 \gg f^2$ which can be derived by the method given by Stückelberg and Patry.[6]

[1] S. M. Dancoff and R. Serber, Phys. Rev. **61**, 394A (1942).
[2] W. Pauli and S. M. Dancoff, Phys. Rev. **62**, 85 (1942).
[3] H. J. Bhabha, Proc. Roy. Soc. **A178**, 314 (1941).
[4] M. Fierz, Helv. Phys. Acta **14**, 257 (1941).
[5] W. Heitler and H. W. Peng, Proc. Camb. Phil. Soc. **38**, 296 (1942).
[6] E. C. G. Stückelberg and J. F. C. Patry, Helv. Phys. Acta **13**, 167 (1940). E. C. G. Stückelberg, Helv. Phys. Acta **13**, 347 (1940).

**26. On the Theory of a Mixed Pseudo-Scalar and a Vector Meson Field.** S. KUSAKA AND W. PAULI, *The Institute for Advanced Study.*—The authors have investigated in more detail Schwinger's[1] modification of Møller-Rosenfeld's theory of nuclear forces which is based on a mixture of a pseudo-scalar and a vector meson field. With the assumption of an extended source of the nucleon, the strong coupling condition is fulfilled, and if the coupling constants of the two fields are taken to be equal, the excitation energy of the isobars turns out to be $\frac{1}{3}$ of its value in the pseudo-scalar theory. The interaction between two nucleons is described with sufficient accuracy by a Hamiltonian which consists of three parts: (1) the isobar excitation energy of the nucleon; (2) the kinetic energy of the nucleon; and (3) the potential energy of the interaction between the nucleons. In the most interesting case of the symmetrical theory, the last expression is the same as the corresponding expression of the weak coupling theory with the spin and the isotopic spin matrices replaced by the more general $e_k{}^\alpha$ vectors of Pauli and Dancoff. A classification of the energy levels of the two-nucleon system has been made, and a preliminary estimate indicates that a suitable choice of the coupling constant and the masses of the mesons can be made in such a way that the binding energy and the quadrupole moment of the deuteron agree with the observed values, and such that the size of the source is small compared to the Compton wave-lengths of both mesons and that the excitation energy of the isobar is large compared to the binding energy of the deuteron. However, this theory gives for the magnetic moment of the deuteron a value only a few percent of the observed value, and the difficulties for higher nuclei described in the preceding paper are also present here. Hence we propose to consider this theory in the weak coupling scheme with a point source of the kind described in the preceding paper. More accurate calcula-

tions for the wave functions of the ground state of the deuteron are in progress.

J. Schwinger, Phys. Rev. **61**, 387A (1942).

**27. On the Meson Field Theory of the Magnetic Moment of Proton and Neutron.** J. M. JAUCH, *Princeton University.*—It is shown that the application of the λ-limiting process together with Dirac's introduction[1] of a second type of field oscillators with negative energy leads in the case of the pseudo-scalar theory to a convergent result for the magnetic moment of the heavy particles in the approximation of the order of the square of the coupling constant.

[1] P. A. M. Dirac, Proc. Roy. Soc. **A180**, 1 (1942).

**28. Ionization Yield of Radiation Energy.** U. FANO, *Carnegie Institution of Washington.*—According to experiments with ionizing radiations acting on various substances, the average energy absorbed per ionization produced is approximately 30–35 ev and bears no apparent relation to the ionization potential of the particular substance. Bagge's theoretical calculation of this energy proved correct for atomic hydrogen, but for other substances incorrectly indicated a positive correlation with the ionization potential.[1] This discrepancy is accounted for qualitatively by giving proper consideration to the fact that most energy absorptions are due to electric dipole oscillations. Available theoretical information shows that the oscillator strength of ionization in certain characteristic atoms is directly and critically related to their ionization potential: the greater the energy actually required to ionize individual atoms, the smaller is the average energy "wasted" in producing excitations. A crude theory complementary to Bagge's has been applied to H and He. It indicates that the factor considered here is essentially sufficient to balance the great difference between the ionization potentials of these two atoms. This accounts for one particularly puzzling feature of the known experimental data, but does not positively establish a yield of one ionization per every 30–35 ev as a theoretical result valid for all substances.

[1] E. Bagge, Ann. der Physik **30**, 72 (1937).

**29. A High Pressure Cloud Chamber of New Design.** T. H. JOHNSON, R. P. SHUTT AND S. DE BENEDETTI, *Bartol Research Foundation.*—A cloud chamber is described which operates at a pressure of 200 atmospheres without the difficulty of having to subject its transparent walls to high pressure differentials. The chamber consists of a glass ring of $\frac{1}{4}$-inch wall thickness 12 inches in diameter and 3 inches deep covered on the front with a $\frac{3}{8}$-inch thick glass plate of the same diameter and on the back with a synthetic rubber diaphragm. The chamber is mounted in the center of a large steel tank. The tank is filled with transparent white oil which subjects the outside of the cloud chamber to a hydrostatic pressure equal to the internal gas pressure. The chamber is compressed by pumping additional oil into the tank, and it is expanded by releasing a valve connecting the tank with an evacuated vessel of adjusted volume. Ample space is provided inside the tank for magnetic field coils and the heavy walls of the tank will serve as the magnetic conductors. The apparatus has already been operated at a pressure of 110 atmospheres giving excellent cosmic-ray tracks. At this pressure its efficiency for observation of rare events such as mesotron decay is about 1000 times that of a chamber of the same size operating at atmospheric pressure.

**30. Some Results Obtained with a New High Pressure Cloud Chamber.** S. DE BENEDETTI, T. H. JOHNSON, AND R. P. SHUTT, *Bartol Research Foundation.*—460 pictures have been taken in a newly designed high-pressure cloud chamber, most of them in an atmosphere of *n*-propyl alcohol, water vapors, and argon at a pressure of 110 atmospheres. The volume expansion ratio decreases almost linearly with pressure, and at 110 atmospheres it becomes as low as 1.05. Owing to small diffusion at such pressures, the sensitive time of the chamber is increased by almost 10 times that at normal pressure, making counter control unnecessary. At 110 atmospheres each random picture contains the equivalent of 3 full length tracks, corresponding to more than $10^4$ cm of air at normal pressure. A total length of $5\times10^6$ cm of air equivalent has been observed, which equals the track length obtained in 500,000 random pictures, or 150,000 pictures controlled by counters, in a cloud chamber of the same dimensions but at normal pressure. Among the results obtained are several cases of heavily ionized tracks attributable to the proton component, one case of a mesotron disintegration, and several pictures of "knock on" electrons of energies above 20 Mev produced in the gas. Typical pictures will be shown.

**31. Experiments Concerning the Origin of the Second Hump in the Rossi Curve.** W. F. G. SWANN, *Bartol Research Foundation of the Franklin Institute.*—Former experiments at the Bartol Foundation have confirmed the existence of the second hump. These experiments have now been varied in a manner calculated to give further information on the significance of the hump. The minimum between the two humps occurs at a thickness of about 10 cm of lead. After carrying observations out to this thickness, the thickness was further increased by the addition of tin. This caused an immediate rise in the curve of an amount comparable with that for the first hump in tin itself. On the other hand, when a similar experiment was performed starting with a thickness of tin corresponding to the minimum and increasing the thickness by the addition of lead, a diminution in the intensity of shower production with increase of thickness was observed. These experiments were suggested by an attempt to account for the second hump on the hypothesis of the creation of electrons by the primary radiation after a certain degree of penetration, and their significance is discussed in relation to this view.

**32. Production of Mesotrons by Ionizing and Non-Ionizing Radiation.** MARCEL SCHEIN AND JULIUS TABIN, *University of Chicago.*—A cosmic-ray balloon experiment was carried out in the stratosphere using Geiger-Mueller counters in 6 different 4- and 5-fold coincidence arrangements. The equipment reached an altitude corresponding

to 2.5 cm of Hg pressure. The following phenomena were investigated: (a) single mesotrons produced in 2 cm of Pb by non-ionizing rays, (b) multiple production of mesotrons by ionizing and non-ionizing rays, (c) cascade showers below 2 cm of Pb produced by electrons and photons, (d) high energy electron showers. Each individual event was registered separately on the same film and it was possible to obtain all the correlations between the different events. The results obtained can be summarized as follows. At a pressure of 3 cm Hg (first radiation unit from the top of the atmosphere) 47 percent of the penetrating particles is accompanied by multiples (mesotron showers) produced by ionizing-rays in 7 cm of lead. The producing radiation probably consists of primary protons. At altitudes higher than 14 km the number of mesotrons produced by non-ionizing rays in a lead thickness of 2 cm is as high as 28 percent of the intensity of the penetrating component. The mesotrons produced in this process are of relatively low energies (1 to $2\times10^8$ ev) and most of them (87 percent) occur in singles. The other 13 percent probably consists of mesotron pairs or mesotron-proton pairs. The non-ionizing rays producing these mesotrons appear to be low energy photons. Practically none of these processes was accompanied by cascade showers registered below 2 cm of Pb.

## SATURDAY AFTERNOON AT 2:00 O'CLOCK

## Joint Session of ASXRED and Physical Society

### Invited Paper

P. DEBYE, *Cornell University:* **Recent Developments in X-Ray and Electron-Diffraction.**

### Contributed Papers

**33. X-Ray Diffraction Investigation of Sodium Stearate from Room Temperature to the Melting Point.** ALEXANDER DE BRETTEVILLE, JR. AND JAMES W. MCBAIN.—X-ray photographs were obtained of the $\gamma$-form[1] of sodium stearate by means of a heating camera[2] starting at room temperature and continuing through the melting point at 288°C to 301°C. The photographs show a gradual coming together of the two most intense side spacings to form a single broad line, somewhere between a temperature greater than 145°C and less than 170°C. Since a phase change[3] exists at 167°C it is assumed that this is the temperature at which the radical change in structure takes place. Orientation of the long spacings is exhibited at 301°C. Complete interpretation of the photographs is not possible because of a lack of crystal structure data. However, assumptions can be made about the structure from other sources that enable one to show that sodium stearate exhibits phenomena analogous to phenomena exhibited by the paraffins.[4]

[1] A. de Bretteville, Jr. and J. W. McBain, Science, **96**, 470 (Nov. 20, 1942).
[2] A. de Bretteville, Jr., Rev. Sci. Inst., **13**, 481 (1942).
[3] M. J. Vold, J. Am. Chem. Soc. **63**, 163 (1941).
[4] A. Müller, Proc. Roy. Soc. **138**, 514–530 (1932).

**34. The Shape of the Debye-Scherrer Lines.** C. C. MURDOCK, *Cornell University.*—The equation for the shape of the Debye-Scherrer line has been derived for crystals of uniform size for the following cases: the $(h\,k\,l)$ line for tetrahedral and cubic crystals, the $(h\,k\,o)$ and $(h\,k\,k)$ lines for octahedral crystals and the (100), (110), and (111) lines for rhombic-dodekahedral crystals. When the crystal has a center of symmetry, the lines associated with Bragg planes which are approximately parallel to crystal faces have secondary maxima. Because of these the estimation of line breadth from experimental data in terms of "integral breadth" is less reliable than in terms of "half intensity breadth," $B_{\frac{1}{2}}$. Let $K=(B_{\frac{1}{2}}v^{\frac{1}{3}}\cos\theta)/\lambda$ in which $v$ is crystal volume. For the dodekahedron, (100) and (110), $K=0.87$; (111), $K=0.91$. For the octahedron, K ranges from 0.82, (100), to 0.94, (111). For the cube, from 0.83, (110), to 0.91, (311), (411), and (511). For the tetrahedron, from 0.73, (110), to 1.03, (100). The equations give the same values for "integral breadth" as those computed by Stokes and Wilson.[1] For measurement of particle size, a line should be used for which $K$ is insensitive to crystal shape. The results so far obtained suggest the (210) reflection, $K=0.89\pm0.02$, for this purpose.

[1] Proc. Camb. Phil. Soc. **38**, 313 (1942).

**35. An X-Ray Diffraction Study of the Age-Hardening of a Cu-Al Alloy.** CHARLES H. TOWNES AND WHEELER P. DAVEY, *The Pennsylvania State College.*—The age-hardening of Cu–Al alloys has been studied by many investigators using density, elastic limit, elongation, hardness, electrical conductivity, and lattice parameters. Results are summarized elsewhere.[1] The present work (using balanced filters and Geiger-Mueller counters) shows the time rate of change of the diffracting powers of the atomic planes of the Cu–Al solid solution and of its decomposition products ($\theta'$ and $\theta$). Pre-strained 25S alloy was heated for 24 hours at 540°C (to dissolve all the Cu in the Al) and then water-quenched at 20°C. The Cu was then allowed to migrate at 309°C. It was found that: (1) In the Al "solid solution" phase the diffracting power of the (111) planes decreased to a constant value in 120 hours; the (100), (110), and (311) planes showed a decreased diffracting power followed by a considerable increase. (2) The (112) (2) plane of $\theta'$ decreased to a constant diffracting power in 120 hours. (3) The (001) (3), (101) (2), (112), (110) (2), and (211) planes

of $\theta$ increased in diffracting power to a constant value in approximately 120 hours. Definite interpretations of the above are offered.

[1] "Age Hardening of Metals," Am. Soc. for Metals (1940).

**36. X-Ray Measurement of Short Range Order and Long Range Order in $Cu_3Au$.** Z. W. WILCHINSKY, *Massachusetts Institute of Technology.*—From a powder pattern, the value of long range order, $S$, can be obtained from intensity measurements of the superstructure lines. When $S$ is zero it is possible to obtain the value of short range order by applying Fourier integral analysis to intensity measurements of the diffuse background. From diffraction theory the background intensity for the alloy $A_3B$ is proportional to $(f_A-f_B)^2\ (3-\Sigma_i \sigma_i c_i \sin kr_i/kr_i)$ where $f_A$ and $f_B$ are the atomic scattering factors, $k=4\pi \sin\theta/\lambda$, the $r_i$'s are the interatomic distances, $c_i$ is the number of atoms at distance $r_i$ from a given atom, and $\sigma_i$ is the generalized form of the short range order parameter as defined by Bethe. The dominant parameter, $\sigma_1$, was found to be 0.19 for sample quenched from 750°C; 0.55 for 540°C; and 0.67 for 400°C. The intensity of a superstructure line is proportional to $S^2(f_A-f_B)^2$. Values of $S$ obtained are 0.842 for sample held at 250°C; 0.814 for 370°C and 0.804 for 380°C.

**37. A Simplified Electron Microscope.** C. H. BACHMAN AND SIMON RAMO, *General Electric Company.*—An electron microscope has been constructed to test a number of new attacks. The aim has been to obtain a resolving power in the range of the greatest present usefulness of electron microscopy (say ten times better than light microscopy), operating at a voltage range sufficient to obtain this resolution for the usual thin specimens, in as simple a manner as possible. The instrument is a combined electron and light microscope and utilizes unipotential electrostatic electron lenses. It has the following desirable characteristics: (1) The electrons are accelerated and focused by a single crudely regulated voltage. (2) The unipotential lenses can readily be used in a multiple-stage magnifying system of compact construction so that the chamber to be evacuated becomes very small. (3) A short electron path results from the use of a multiple lens electron-optical system in combination with a stage of light-optical magnification. This small cathode to fluorescent screen distance and the medium resolving power aim make it possible to align the entire electron-optical system permanently. (4) The chamber can be re-evacuated to operating conditions within a few minutes after insertion of a new specimen. (5) The overall weight and dimensions, if proper advantage is taken of the above conditions, are such that it is feasible to design a portable instrument.

**38. Compact Electron Microscope with Magnetic Lenses.** V. K. ZWORYKIN AND J. HILLIER, *RCA Manufacturing Company.*—To meet the demand of a small, simply operated and inexpensive electron microscope, a desk-type instrument has been developed, with a total length from electron source to observation screen or photographic plate of only 16 inches. The objective and projector lenses are of a new design, and the magnetomotive force is provided either by a coil or by permanent magnets. Focusing is accomplished by varying the stabilized operating voltage, normally maintained in the neighborhood of 30 kilovolts. The illumination is controlled by a bias voltage applied to a grid cylinder surrounding the cathode. The total volume of the instrument being only about 1 liter, airlocks are superfluous; the pumping-out time required for complete evacuation is only about 2 minutes. The microscope is mounted so that the observer views the final image directly on the rear of a transparent fluorescent screen.

**39. Distance to Which the Attractive Field of a Solid Extends into a Liquid.** WILLIAM D. HARKINS AND GEORGE JURA, *University of Chicago and the Universal Oil Products Company, Chicago.*—Various estimates of the distance to which the attractive field of a crystal extends into an adjacent liquid vary from the thickness of one to several thousand monolayers. A method has been developed for the determination of the variation of the energy with the distance. A definite amount of the vapor of the liquid is adsorbed on the surface of the solid, which must give a zero contact angle with the liquid. The powder if then immersed in the liquid in a sensitive calorimeter. The determination of area is described in the following paper. From the integral curve the energy of desorption per molecular layer, is calculated. With titanium dioxide (anatase) and water the excess of the energy of desorption over that for vaporization (10480 cal. $mole^{-1}$) for the successive molecular layers is; 5360, 480, 110, 60, and 20 cal. $mole^{-1}$. Quartz would give slightly higher values. Although the energies of attachment of the higher layers are very small, films of slightly over nine layers of water or of nitrogen have been obtained before saturation is attained. The accuracy of the values can be improved by more extensive experimental work.

**40. A Method for Determining the Area of a Crystalline Powder without the Assumption of a Molecular Area.** GEORGE JURA AND WILLIAM D. HARKINS, *University of Chicago and Universal Oil Products Company.*—Emmett, Brunauer, and Teller have developed a gas adsorption method which gives the volume of gas adsorbed to fill the first monolayer on the surface of a solid. If the molecular area were known for each case the area could be calculated. In the application of this method they used porous solids of extremely large area, while we employed nonporous crystalline powders. We have developed a new method, independent of any assumption of a molecular area, based on a proof that a solid surface which gives a zero contact angle with a liquid is covered by a duplex film of that liquid when in equilibrium with saturated vapor. A duplex film is one just thick enough to exhibit the same surface energy as the liquid itself. At 250°C fine crystals of titanium dioxide, in equilibrium with saturated water vapor, and therefore covered by a duplex water film, were immersed in liquid water. Since the surface energy was that of water (118.5 erg $cm^{-2}$), the total energy of immersion, divided by this value, gave the area (14.0 meter $g^{-1}$), while nitrogen adsorption gave *exactly the same area when* Emmett's molecular area of 16.2$A^2$ was assumed.

## SUPPLEMENTARY PROGRAMME

**41. Raman Spectra of Methylheptenes.** FORREST F. CLEVELAND, *Illinois Institute of Technology.**—Continuing work on olefinic hydrocarbons containing eight carbon atoms, the Raman frequencies, relative intensities and depolarization factors of 2-methyl-1-heptene and 6-methyl-1-heptene have been obtained. The relative intensities and depolarization factors were obtained by use of a Gaertner microdensitometer. The strong lines characteristic of the $RHC=CH_2$ group, previously observed at 1293(94)0.88, 1415(42)0.77, 1641(134)0.15 and 3078(23)0.93 for 1-octene, appear at 1295(247)0.44, 1417(115)0.54, 1644(334)0.19 and 3079(29)*D* for 6-methyl-1-heptene. For 2-methyl-1-heptene, in which the group is $R(CH_3)C=CH_2$, the corresponding lines were observed at 1303(56)0.51, 1414(119)0.71, 1653(222)0.13 and 3077(21)*D*. It may be noted that the 1653 frequency is higher for the $R(CH_3)C=CH_2$ group than the corresponding value of 1442 in the $RHC=CH_2$ group. Furthermore, the frequency which was constant at 3000 $cm^{-1}$ for the four octenes previously studied and for the 6-methyl-1-heptene drops to 2978 $cm^{-1}$ for the 2-methyl-1-heptene. The line 1334(48)0.53 in the spectrum of 6-methyl-1-heptene was not observed for the 2-methyl-1-heptene or for the four octenes previously studied while the line observed at 1383(70)0.51 for the latter compound was observed in the previous investigation only for *cis*+*trans* 2-octene and *trans*-3-octene. A line at 1674 in the spectrum of 2-methyl-1-heptene indicates the presence of some *trans* olefin as an impurity.

* To be called for after Paper No. 22 if time permits.

**42. A Method for the Accurate Determination of the Adsorption of a Vapor on the Surface of a Solid.** WILLIAM D. HARKINS AND GEORGE JURA, *University of Chicago.**—While it is easy to obtain a moderately accurate isotherm for the adsorption of a vapor on a porous solid by the ordinary volumetric method, or by a McBain-Bakr quartz spiral, these methods are not accurate if non-porous sheets of powders are under investigation. Our method is extremely accurate, not affected by time, and as many temperatures as are desired may be used. (1) As large a sample of sheets or powder as possible is put in a glass bulb in which it can be outgassed. During the adsorption process this bulb is kept in a thermostat. (2) The samples of liquid are placed in sealed glass bulbs filled with proper amounts of the liquid. The empty and full bulbs are weighed on an analytical or a microbalance, and are held in a horizontal tube which is attached by a vertical tube to the adsorption bulb, and also to a small sensitive manometer. The horizontal tube is supplied with a mechanism to break any single bulb as desired. (3) In the application of this method it is often possible to adsorb on the solid 99 percent of the mass of liquid in the bulbs. The manometer is used to obtain the vapor pressure in order that the mass of vapor unadsorbed may be determined.

* To be called for after Paper No. 40 if time permits.

**43. The Lift Function for an Oscillating Airfoil.*** W. C. RANDELS AND S. SILVER, *University of Oklahoma.*—A method used by Biot[1] is applied to an airfoil undergoing torsional oscillations. The usual approximations of the linearized theory for thin airfoils have been made. The boundary conditions are shown to be satisfied by a function consisting of the sum of three functions corresponding to elementary singularities. The total lift and moment are given.

* To be read by title.
[1] M. Biot, J. Aer. Sci. 9, 185 (1942).

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